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ART. III.—*A Revision and Description of the Australian Tertiary Patellidae, Patelloididae, Cocculinidae, and Fissurellidae.*

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AND

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(With Plates I.-III.)

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Introduction.

There has been considerable confusion in the past regarding the specific and even generic standing amongst one of our commonest groups of Australian Tertiary Mollusca, viz., the patelloid and emarginuloid forms. The present work has been undertaken with a view to clearing up some of these difficulties.

We have had the special advantage of handling the principal collections containing these forms and which comprise the National Museum collections (Dennant coll., Mulder coll., and Sweet coll.), as well as the private collections of Messrs. F. A. Cudmore (including part of the T.S. Hall coll.), F. A. Singleton, W. J. Parr, Miss Crespin, and F. Chapman. We have, therefore, critically examined probably more than a thousand specimens. Our thanks are due to Messrs. Cudmore and Singleton for the loan of their specimens, and in cases where specified, for the donation of selected types; whilst Miss I. Crespin, B.A., has kindly assisted us in regard to the fauna of Green Gully, Keilor.

An especial feature of this descriptive work was the comparison between the fossil and living faunas, in which the persistent life-history of the specific forms were clearly seen, and in some cases ranging from Oligocene times, at the most, with only slight morphological variations.

In regard to one of the most difficult questions arising from insufficient description, that of the actual identity of *Emarginula transenna*, T. Woods, we are under great obligations to Mr. W. L. May, of Forest Hill, Sandford, Tasmania, who lent us specimens for comparison, and to the Curator of the Tasmanian Museum, Hobart, Mr. Clive E. Lord, F.L.S., who kindly allowed us to see the Johnston Homoeotype.

Systematic Descriptions.

Fam. PATELLIDAE.

Genus *Cellana*, Adams, 1869.*CELLANA CUDMOREI*, sp. nov. (Plate I., fig. 1; pl. III., figs. 27, 28.)

Description.—Shell large, elevated, oval, rather strongly built; apex situated about one-third from the anterior margin. Sculpture consisting of numerous strong riblets, with two or three smaller ones occupying the interspaces. Growth-lines undulate, fine, not well developed. Interior of shell having the convexity of the external riblets indicated by deep grooves, which are crossed by fine lines of growth. These radial grooves of the interior may possibly have become more distinctly engraved on account of a certain amount of dissolution of the shell, especially the nacreous layer of the interior, and owing to its peculiar preservation in the polyzoal limestone matrix.

Dimensions.—Length, 40 mm. Greatest width, 30 mm. Height, circ., 10 mm. Width of coarser riblets at margin of shell, circ., 1.75 mm. About three of the strong riblets go to 10 mm. on the anterior margin, as in a full grown living specimen of the limpet, *Cellana variegata*, Blainville sp. (*Patella tramoserica* of authors).

Observations.—The above species appears to be the ancestral form of *Cellana variegata*, Blainv. sp. It differs, however, in having a more depressed and narrower shell.

Occurrence.—Holotype. From the Miocene (Janjukian) polyzoal rock of Batesford, near Geelong. The type was found by Mr. F. A. Cudmore, after whom the species is named, and who has presented the specimen to the National Museum.

CELLANA HENTYI, sp. nov. (Plate I., fig. 2.)

Description.—Shell of medium size, elevated, narrowly oval, apex a little in front of the centre. In the present state of fossilisation the apex is denuded of ornament. Surface ornament consisting of moderately strong radiating ribs, with several intermediate, less pronounced riblets; these are crossed by growth-lines which are strongly undulate and which are produced at the intersections into nodulose growths. Shell still retaining its natural colour, from olive green to black.

Dimensions.—Length, 20 mm. Width, 14.5 mm. Height, 10.5 mm.

Observations.—This species is more elevated and longitudinally compressed than the living *Patella squamifera*, Reeve¹, but in some respects the ornament agrees in having the radii produced into nodulous outgrowths, though not to so marked a degree. On the other hand comparison may be made with the recent *Cellana variegata*, Blainville, sp.², especially in the height of the shell and the

1.—Conch. Icon., vol. VIII. 1855, pl. XXXII, fig. 94. Hedley, Austral-Antarctic Exped., Mollusca, 1916, p. 43, fig. 2.

2.—*Patella variegata*, Blainville, Dict. Sci., Nat., vol. XXXVIII. 1825, p. 10. *Cellana variegata* Blainville, sp., Hedley Proc. Linn. Soc., N.S.Wales, vol. XXXIX. 1915, p. 714.

character of the ribs, which are not so squamose as in the above quoted species.

Named in honour of Mr. Archie Campbell Henty, from whom the authors had much kindly assistance in collecting at this locality.

Occurrence.—Holotype. Lower Pliocene (Kalimnan) shell bed at Forsyth's, Grange Burn, near Hamilton. Type found by F. Chapman and presented to the National Museum.

Fam. PATELLOOIDIDAE.

Genus PATELLOIDA, Quoy and Gaimard, 1834.

PATELLOIDA HAMILTONENSIS, sp. nov. (Plate I., fig. 3.)

Description.—Shell solid, irregularly oval, strongly ribbed; apex sub-central, much eroded and probably originally smooth. The sculpture consisting of about ten rather prominent radiating ribs, the inter-spaces of which are occupied by finer riblets of varying strength. About three irregular growth stages are discernible on the shell surface, which are marked by slight overlapping or sulcation. The area between the major ribs, depressed or fluted, resulting in an undulose margin to the shell. Colour, pale ochre.

Dimensions.—Length, 13 mm. Width, 12 mm. Height, 5.5 mm.

Observations.—This species approaches *Patelloida perplexa*, Pilsbry³, but differs in the ribs being less pronounced and not salient at the margins.

Occurrence.—Lower Pliocene (Kalimnan). Holotype and two others; Dennant coll., Muddy Creek, upper beds (probably MacDonald's). Another example, presented by the late J. H. Young, 13/5/13.

PATELLOIDA MULTIRADIALIS, sp. nov. (Plate I., fig. 4; pl. III., fig. 29.)

Description.—Shell of median size, thin, roundly oval, depressed conical; apex almost central. Surface ornamented with ribs exceeding 100; some of these are intermediate and smaller than the main ribs. Growth lines rather obscure but producing a tegulate appearance on crossing the ribs. In the apical area the riblets are beaded in character, but towards the margin the ornament appears as overlapping scales. Interior polished, margin crenulated, with hollow sulci.

Dimensions.—Length, 14.5 mm. Width, 12.5 mm. Height, 5.25 mm.

Observations.—In some points this species resembles the living *P. calamus*, Crosse and Fischer, sp.⁴, of Port Phillip and Western Port, but differs in the more depressed form of shell, its rounder outline and the more scaly character of the ribs.

3.—*Acmaea saccharina*, var. *perplexa*, Pilsbry, Man. Conch., vol. XIII., 1891, p. 50, pl. XXXVI., figs. 69-71.

4.—*Patella calamus*, Crosse and Fischer, 1864, Journ. de Conch., p. 248. *Id.*, *ibid.*, 1865, p. 42, pl. III., figs. 7, 3.

Occurrence.—This species is represented by a unique specimen, from the Balcombian (Oligocene), towards the upper part of the Clifton Bank. Type presented to National Museum by F. Chapman.

PATELLOIDA PERPLEXA, Pilsbry, sp.

Patella octoradiata, Hutton, 1873 (non Gmelius 1791), Cat. Marine Moll. New Zealand, p. 44, No. 201.

Acmaea saccharina, var. *perplexa*, Pilsbry, 1891, Man. Conch., vol. XIII., p. 50, pl. XXXVI., figs. 69-71.

Patella perplexa, Pilsbry, Pritchard and Gatliff, 1903, Proc. Roy. Soc. Vic., Vol. XV. (N.S.), pt. 1, p. 194.

Acmaea octoradiata, Hutton, sp., Hedley, 1904, Proc. Linn. Soc. N.S.Wales, vol. XXIX, pt. I., No. 113, p. 188. Pritchard and Gatliff, 1905, Proc. Roy. Soc. Vict., vol. XVIII. (N.S.), p. 65. Verco, 1906, Trans. Roy. Soc. S. Australia, vol. XXX., p. 209. Chapman, 1912, Proc. Roy. Soc. Vict., vol. XXV., pt. I., p. 186, pl. XII., figs. 1, 2. Suter, 1913, Man., N.Z., Moll., p. 75, pl. VII., fig. 6.

Patelloida perplexa, Pilsbry, sp. Iredale, 1915, Trans. N.Z. Inst., vol. XLVII., p. 430.

Observations.—Since writing the account of the first fossil occurrence of the above species by one of us (F.C.) a new locality besides that of Flemington has been found by Miss I. Crespin, B.A., at Green Gully, Keilor. The examples there found are also in the form of casts, but the moulds show the style of ornament and its variational tendency as with the recent forms, and wax squeezes of the moulds give a good idea of the fine radial ornament.

Occurrence.—Janjukian (Miocene). Flemington Railway cutting, ironstone beds (J. S. Green coll.). Green Gully, Keilor, in ironstone (Miss I. Crespin coll.).

Fam. COCCULINIDAE.

GENUS *Cocculina*. Dall., 1882.

Cocculina praecompressa, sp. nov. (Plate I., figs. 5, 6, 7, 8.)

Description.—Shell small, laterally compressed, narrowly ovate, elevated; apex distinct, reverted anteriorly and slightly eccentric. Sculpture consisting of fine growth-lines. Apex white, the remainder of shell being ivory yellow.

Dimensions.—Length, 3.75 mm. Width, 2 mm. Height, 2.5 mm.

Observations.—The present species shows some closely comparative features with the living *C. compressa*, Suter⁵, especially in the compressed outline and in the height of the shell. The apex of the present species, however, is more prominent and salient, and the

5.—Suter, H., Proc. Malac. Soc., vol. VIII., 1908, p. 27, pl. II., figs. 17, 18. Idem, Manual of New Zealand Mollusca, 1913, p. 174, pl. XXXIV., figs. 14, 14a.

anterior slope is more convex, the posterior being more concave. The other example we figure from Shelford (Pl. I., figs. 5, 7, 8) is a broader form, which at present we are inclined to regard as a local variation.

Occurrence.—Balcombian (Oligocene); from the older beds at Muddy Creek. This Holotype was presented to the National Museum by Mr. J. H. Young. Also from beds of the same age in the same locality, in Dennant and Cudmore colls. From Balcombe Bay, Port Phillip, coll. by W. Kershaw (Nat. Mus.); Janjukian (Miocene); Shelford, Dennant coll.

COCCULINA GUNYOUNGENSIS, sp. nov. (Plate I., figs. 9, 10.)

Description.—Shell comparatively large, roundly oval, capuloid, fairly high; apex subcentral and prominent with a slight twist to the right anterior. Surface generally slightly convex, excepting at posterior slope, where it is depressed or even concave. Shell nearly smooth, but with fine growth-lines crossed by excessively fine radii.

Dimensions.—Length, 9 mm. Width, 7.5 mm. Height 5.5 mm.

Observations.—The present species in some respects approaches *Addisonia lateralis*, Requien, sp.⁶ but that it is more convex, with the growth-lines more pronounced. In view of the fact that the apex of our shell is asymmetrical, the new species may have to be placed in the genus *Addisonia*.

Occurrence.—Holotype from Balcombian beds (Oligocene); Grice's Creek (formerly Gunyoung Creek), Port Phillip. Also of same age from Balcombe Bay (W. Kershaw coll.); Muddy Creek, older beds (Dennant coll.).

Fam. FISSURELLIDAE.

Genus *Emarginula*, Lamarck, 1801.

Synopsis of the Genus *Emarginula*:

Name.	Altitude.	Outline.	Costae.	Slit fasciole.	Base.
<i>E. wannonensis</i> , Harris	High	Broadly ovate	Nodulose	Costate	Laterally concave
<i>E. transenna</i> , T. Woods	High	Broadly ovate	Latticed	Costate	Flat
<i>E. mandensis</i> , Chapm. & Low		Elongate-ovate	Few; nodulose	Costate	Flat
<i>E. dennanti</i> , Ch. & Gab.	Low	Elongate-ovate	Numerous; undulose- tegulate	Sulcate	Flat
<i>E. delicatissima</i> , Ch. & Low		Elongate-ovate	Numerous; fine and horizontally cancellate	Sulcate	Flat

EMARGINULA DELICATISSIMA, sp. nov. (Plate I., figs. 11, 12; pl. III., figs. 30, 31.)

Description.—Shell elongate-ovate, depressed, slightly narrower anteriorly; apex recurved and close to anterior margin. Posterior

6.—*Gadina lateralis*, Requien, Coq. de Corse, 1848, p. 39. *Addisonia lateralis*, Req. sp., Pilsbry, Man. Conch, vol. XII., 1899, p. 139, pl. xxv. figs. 26, 27.

region flattened towards margin, the remainder generally convex. Sculpture: ornamented with a series of rounded radial ribs, crossed by delicate concentric threads producing a fine cancellation; between main, ribs one or more fine secondary ribs. Slit-fasciole situated between two sharp ridges and filled in with a concentrically layered callus. This fasciole is represented in the interior of shell by a well-marked groove, bounded by rounded ridges. Internal margin of shell marked by a denticulated border, the serrations of which are more or less truncated.

Dimensions.—Length, 10.5 mm. Width, 6 mm. Height, 5.25 mm. Length of slit, 3.5 mm.

Observations.—This is the most finely sculptured form of our Australian Tertiary species of the genus.

Occurrence.—Balcombian (Oligocene); type from Balcombe Bay, (Dennant coll.); Table Cape, Tasmania, Gellibrand River and Inverleigh (F. A. Cudmore and W. L. May coll.); Fyansford (F. A. Singleton coll.); in ironstone, Lake Mundi, Casterton (Coll. Z. Neall).

Janjukian (Miocene); Shelford, Mitchell River and Torquay, Dennant coll.; Table Cape, Tasmania, Gellibrand River and Inverleigh (F. A. Cudmore and W. L. May coll.); Fyansford (F. A. Singleton coll.); in ironstone, Lake Mundi, Casterton (Coll. Z. Neall).

***EMARGINULA DENNANTI*, sp. nov. (Plate I., figs. 13, 14; pl. III., fig. 32.)**

Description.—Shell large, fragile, ovately-conical, moderately high; apex comparatively small, strongly recurved, situated about one-third from posterior margin. Surface of shell strongly convex anteriorly, moderately convex posteriorly. Sculpture consisting of about 24 well-defined, radiating ribs, between which are secondary riblets, and between these again a fainter tertiary series. Concentric ridges undulating and lamellose, and where they cross the radials, a tegulate appearance is produced. Slit-fasciole situated between two sharp ridges; callus formed of distinct concave lamellae. Inner margin of shell bluntly denticulated. Slit-fasciole interorly marked by a fine groove with swollen margins.

Dimensions.—Length, 20.5 mm. Width, 14.75 mm. Height, 9.75 mm. Length of slit, 5.25 mm.

Observations.—The concentric lamellose character and the regulation of the ribs make this species easily identifiable from other related forms.

This species was tentatively named by J. Dennant in his collection as "aff. *transenna*," from which it differs in its longer shell and more central apex.

Occurrence.—Balcombian (Oligocene); type from Grice's Creek, (J. F. Bailey coll.) Also from Altona Bay Coal Shaft, Balcombe Bay and Muddy Creek, (Cudmore coll.); Muddy Creek, (Dennant coll.).

Janjukian (Miocene); Gellibrand River, (Cudmore and Parr colls.) An internal cast of a related, if not identical, shell occurs in the Murray Cliffs at Morgan (F. A. Cudmore coll.).

EMARGINULA MAUDENSIS, sp. nov. (Plate II., fig. 15; pl. III., fig. 33.)

Description.—Shell small, elongate-ovate, of medium height. Apex situated close to the posterior. General surface convex anteriorly, depressed posteriorly. Ornament consisting of about 16 prominent radial ribs which are crossed in concentric lines, forming at the intersection of the ribs a strong beaded character. Slit fasciole filled in with a beaded callus, the slit situated between two sharp ridges.

Dimensions.—Length, 4.5 mm. Width, 2.75 mm. Height, 2.75 mm. Length of slit, 1 mm.

Observations.—The above species appears to be the smallest Victorian Tertiary form. In the style of ornament it suggests a juvenile form of *E. wannonensis*, Harris, but differs in having a more elongate and depressed shape, in the more posterior position of the apex and in its fewer ribs.

Occurrence.—Janjukian (Miocene); Maude, (Dennant coll.).

EMARGINULA TRANSENNA, T. Woods. Plate II., figs. 16, 17.)

Emarginula transenna, T. Woods, 1877, Proc. Roy. Soc. Tas. (for 1876), p. 163. Pritchard, 1896, Proc. Roy. Soc. Vict., vol. VIII. (N.S.), p. 147. Dennant and Kitson, 1903, Rec. Geol. Surv. Vict., vol. I., pt. 2, p. 117. May, 1919, Proc. Roy. Soc. Tas. (for 1918), p. 70, pl. VIII., fig. 1. Id., 1919, *ibid.*, p. 107.

Observations.—The above species has given us not a little trouble in deciding its relationship to many of the commonest forms of this type in Victoria. We have now had the advantage of examining and comparing Topotypes, one from the Hobart Museum (Johnson coll.) and another from Mr. May's private collection, the former having been figured by May in his 1919 paper. We are now satisfied that the so-called "Johnston co-type" figured by May, which of course is merely a topotype, represents a much abraded example of the species. The figure appears to us to suggest a cap or callus on the apex, but it seems that this appearance is due rather to the wearing down of the shell to the subexternal layer. On examining the Johnstonian specimen we find that the slit-fasciole has an abnormally rib-like character, which is really due to the wearing away of the lateral laminae, leaving the intermediate fasciole infilling as a smooth, prominent ridge.

The largest specimen we have met with is from Bird Rock Cliffs (F. A. Cudmore coll.), which has a longer diameter of 21 mm.

Original Description of Tenison Woods:

"Shell thick, small, oblong, subquadrate posteriorly, end slightly produced, conical, high, apex submarginal, smooth, acute, recurved, parallel with the margin, anterior surface ventricose, posterior concave, latticed; radiating ribs 23, high, between them smaller ones, which often in descending give rise to still smaller; transverse ribs raised, but always more sunken than the radiate, and at all the points

of intersection, very projecting granules, interstices very deep and square, fissure slightly longer than width, margin denticulate, straight. Long. 11, Lat. 6, Alt. 6. Fissure, Long, $1\frac{1}{2}$ mill., Lat. $\frac{1}{2}$ mill."

Relationships and Distribution.—In the view that this species is perhaps the commonest of the Victorian emarginulids, one can gain a better idea of the variation of morphological groups both as to time and space. In the Balcombian, which is typically of fairly deep water phase, *E. transenna* is usually represented in these beds as a thinner and more delicately ornamented form, as compared with the Table-Cape type form, which, as an element of the fauna of the "Crassatellites Bed," indicates that the conditions at that locality were fairly shallow water in character. At Corio Bay and Gellibrand, also of Janjukian age, but of deeper water conditions than at Table Cape and more muddy in character, we find the form to tend towards the thinner-shelled variations.

In the species described by Harris⁷ as *E. wannonensis*, we seem to have a parallel form with the above, but very closely related. The distinctive characters which can there be distinguished are seen in the very stout build of the shell and the super-ventriloce anterior, the stronger ornament and the typically concave margin in the median border of the shell. Another distinction is seen in the discrepant growth stages of the shell, which indicate distinct periods of rest. The slit-fasciole is not remarkably differentiated from the rest of the main ribs, as is the case with *E. transenna*.

Occurrence.—In the Balcombian (Oligocene Series), from the Lower Beds at Muddy Creek; Balcombe Bay, Grice's Creek and Altona Bay coal shaft, Port Phillip; in the Janjukian (Miocene Series), from Table Cape, Tasmania (T. Woods and F. A. Cudmore); Green Gully, Keilor (G. Sweet and I. Crespin colls.); Murgheboluc (F. A. Cudmore, T. S. Hall and F. Chapman coll.); Gellibrand; Fyansford; Corio Bay (F. A. Singleton and F. Chapman coll.); Western Beach, Geelong (Dennant coll.); Shelford; Torquay (Cudmore and Dennant colls.).

EMARGINULA WANNONENSIS, Harris.

Emarginula wannonensis, Harris, 1897, Cat. Tert. Moll. Brit. Mus., pt. I. Australasian Tertiary Mollusca, p. 288, pl. VIII., figs. 6a-c Dennant and Kitson, 1903, Cat. Foss. in Cainozoic of Victoria, S. Austral. and Tasmania, Rec. Geol. Surv. Vict., vol. I., pt. 2, p. 117. Suter, 1915, Alphabetical Hand List of New Zealand Tertiary Mollusca. Wellington, p. 9 (referred to as a living species but without comment).

Observations.—In his original description Harris records this species as doubtfully from the Eocene (regarded by us as Oligocene, Muddy Creek, Vict.) It is interesting to note here the extensive range of this species, which we are enabled to show by the present

7.—Cat. Tert. Moll. Brit. Mus. pt. 1, Austr. Tert., Moll. 1897, p. 288, pl. VIII., figs. 6a-c.

series,—from Oligocene to Lower Pliocene. Suter (*op. supra cit.*) has also given it as a living species in New Zealand, but so far we have not met with any occurrence recorded from that or any other area.

The variation in this species is very marked, and speaking generally, the oldest beds (Balcombian) yield the strongest and highest forms; those from the Janjukian are of medium size, whilst the Kalimnan examples, from the Hamilton district, are quite small, being less than a quarter of the size of the older forms. The largest specimen met with (from Clifton Bank, Muddy Creek) has a length of 20 mm., whilst the type described by Harris measures 16 mm.

The smaller and more recent fossil forms of this species resemble *E. transenna*, excepting for the backward position of the apex, which in *E. wannanensis* is vertical with the posterior margin or even overhanging it.

Occurrence.—Balcombian (Oligocene), lower beds, Muddy Creek; Grice's Creek and Balcombe Bay, Port Phillip. Janjukian (Miocene), Gellibrand (Cudmore and Dennant); Murgheboluc (T.S.H. in Cudmore coll.); Shelford (Dennant); Ruttledge's, near Geelong (T.S.H. in Cudmore coll.); Torquay (Dennant); Mitchell River (Dennant); Table Cape Tasmania (Cudmore); Kalimnan (Lower Pliocene), Forsyth's, Grange Burn and MacDonald's, upper Muddy Creek beds (F. Chapman coll.).

Genus MONTFORTULA, Iredale, 1915.

Synopsis of the Genus Montfortula:

Name.	Altitude.	Outline.	Costae.	Base.
<i>M. ponderosa</i> , Chapm. & Gabr.	Very high	Ovate	Numerous; beaded.	Flat.
<i>M. aperturata</i> , Chapm. & Gabr.	Moderately high	Ovate	Numerous; strong; tegulate; interspaces cancellated throughout	Flat.
<i>M. occlusa</i> , Tate, sp. .	Medium	Roundly ovate	Few; interspaces cancellated at apex	Flat.
<i>M. gemmata</i> , Chapm. & Gabr.	Medium to low	Roundly ovate	Numerous; finely beaded	Flat.
<i>M. squamoidea</i> , Chapm. & Gabr.	Low	Roundly ovate	Nodulose; feebly cancellated	Flat.
<i>M. cainozoica</i> , Chapm. & Gabr.	Low	Ovate; laterally compressed	Numerous; fine and delicately beaded	Flat.

MONTFORTULA APERTURATA, sp. nov. (Plate II., figs. 18, 19, 20; pl. III.)
fig. 34.)

Description.—Shell of medium size, elevated, broadly oval; apex acute, subcentral, slightly reverted. Ornament consisting of about 25 strong rounded ribs with smaller intermediate riblets; these are crossed by a series of undulate and tegulate growth lines with slight

interspaces which give a general cancellate appearance to the shell. Slit shallow, hardly discernible. Slit-fasciole bounded by sharp, laminated borders. The lamellae of the callus becoming nodulous, especially towards the anterior. Sides of shell flattened, anteriorly convex, posteriorly concave under apex and becoming slightly convex towards the margin. Interior of shell polished, marked by faint radial lines; margin of shell flattened, with a fluted and denticulate edge. The slit distinguished by being slightly broader and deeper than the remaining flutings.

Dimensions.—Length, 19 mm. Width, 17 mm. Height, 10 mm.

Observations.—The smaller specimens of this species show a variation towards a more narrowly oval contour which almost amounts to be subspecific difference. A beautiful, ornate species; the generally rounded shape and cancellate ornament separating it from its Victorian fossil congeners. The nearest species with which it might be confused is *M. occlusa*, T. Woods, sp., in which the shell, however, begins with a similar ornament to *M. aperturata*, but rapidly becomes filled in to produce a comparatively smooth shell. Its nearest living Victorian representative appears to be *M. rugosa*, Q. and G., sp.⁸ but in this the shell is stronger and more heavily built, of greater height and with the intermediate riblets more numerous; the slit is also more pronounced than in the fossil species, and in the interior of the shell the slit groove is represented as a distinct furrow almost up to the apex.

Occurrence.—Balcombian (Oligocene), Balcombe Bay (F. A. Cudmore); Muddy Creek, lower beds (F. A. Cudmore and F. Chapman). Janjukian (Miocene), Gellibrand River (J. Dennant); Skinner's, near Bairnsdale (J. Dennant); Murray Cliffs, four miles below Morgan, S.A. (F. A. Cudmore).

MONTFORTULA CAINOZOICA, sp. nov. (Pl. II., fig. 21; pl. III., fig. 36.)

Description.—Shell small, roundly oval, rather tenuous, moderately depressed; apex sharp, sub-central, directed posteriorly. Sculpture, of two systems of riblets, the coarser numbering 48, distinctly granulate; finer riblets filling the interspaces to the number of three or four. Growth lines well marked; and there are three or four resting stages showing concentric sulci on the shell. The characteristic short anterior slit is practically obsolete, but its position is indicated in well-preserved specimens by an ill-defined rib.

Dimensions.—Length, 10.5 mm. Greatest width, 9 mm. Height, 3.25 mm.

Observations.—Nothing comparable is known amongst recent species in the Australian region.

M. cainozoica has a general resemblance to *M. gemmata*, but the ornament of the latter is decidedly stronger and the shell is of much stouter build.

Occurrence.—Balcombian (Oligocene). Muddy Creek, near Hamilton. From the Dennant collection, numerous examples. One speci-

⁸.—*Emarginula rugosa*, Quoy and Gaimard, Voy. Astrolabe, Zool., 1834, vol. III., p. 331, pl. LXVIII., figs, 17, 18.

ment in F. Chapman's collection from near the top of Clifton Bank, and another from the base of the section, showing that it ranges throughout the Muddy Creek lower beds.

MONTFORTULA GEMMATA, sp. nov. (Plate II., figs. 22, 23, 24.)

Description.—Shell fragile, the type of medium size, moderately high, apex nearly central, anterior notch barely discernible. Surface slightly convex, ornamented by about 24 radial ribs, with smaller interstitial riblets. Growth lines concentric, and at the point where they cross the riblets are developed into gemmules.

Dimensions.—Length, 12.5 mm. Width, 11.5 mm. Height, 6 mm.

Observations.—In general character and ornament this species appears to have no resemblance to any Australian representatives, either Tertiary or Recent. In regard to the variations of the species, we draw special attention to the great modification of forms found under different conditions in our Australian Tertiaries; for example, the type, which came from the deeper water clays of Balcombe Bay, is a moderately small and comparatively high shell, whilst an extreme form is found apparently in the more sandy and littoral deposits of a part of the Muddy Creek, Clifton Bank section, in which the shell is represented as a depressed form, and which has passed on to a gerontic stage attaining the remarkable length of 31 mm. (See Pl. II., fig. 24.) This variation, which is mainly produced by local conditions, can hardly be regarded as constant, or deserving even a varietal name, since we find every gradation between the elevated and depressed forms. The specimens from Gellibrand are relatively small and perhaps intermediate in the elevation of the apex as compared with the above mentioned examples.

Occurrence.—Balcombian (Oligocene), Balcombe Bay, Port Phillip (F. A. Cudmore); Muddy Creek, Clifton Bank (F. A. Cudmore and R. H. Annear). Janjukian (Miocene), Gellibrand River (J. Dennant).

MONTFORTULA OCCLUSA, Tate, sp. (Plate III., fig. 35.)

Subemarginula occlusa, Tate, 1898, Proc. Roy. Soc. N.S. Wales, p. 405, pl. XX., figs 9a, b. Hall and Pritchard, 1901, Proc. Roy. Soc. Vict., vol. XIV. (N.S.), pt. I., p. 52. Dennant and Kitson, 1903, Rec. Geol. Surv. Vict., vol. I., pt. 2, p. 117.

Observations.—This species is without doubt the commonest and most widely distributed of the Australian Tertiary Montfortulæ. The amount of variation seen in a long series of examples is of a surprising extent. In the brephic and neanic stages the shell resembles in some respects those which we have newly described as *M. aperturata*; but whereas the latter retain their character in later stages, in *M. occlusa* the peculiar latticed character of the early stage is speedily lost. Another difference between them and *M. aperturata* is that the apex in the latter is decidedly more acute and salient.

Both in the Balcombian and Janjukian beds of Victoria the variation of this species is normal, but in the Janjukian or Table Cape (Crassatellites Bed) the examples we have seen have fewer and sharper ribs.

Occurrence.—Balcombian (Oligocene), Muddy Creek (Annear coll., a large specimen); Grice's Creek; Balcombe Bay. Janjukian (Miocene), Curlewis (J. H. Young); Fyansford (F. A. Cudmore); Native Hut Creek (T. S. Hall, in Cudmore coll.); Murgheboluc (F. A. Cudmore); Inverleigh (T. S. Hall, in F. A. Cudmore coll.); Shelford, Gellibrand and Table Cape (F. A. Cudmore coll.).

MONTFORTULA PONDEROSA, sp. nov. (Plate II., fig. 25.)

Description.—Shell large, stoutly built, conical and high, with the apex situated posteriorly. Outline of the shell roundly ovate, often irregular in contour, owing to discontinuous stages of growth. Anterior slope of the shell roundly convex; posterior gently concave. Ornament consisting of from 30 to 40 ribs, which are beaded in character, and between which the interspace is generally occupied by a low rounded riblet, also gemmate. In some examples there are two or more intermediate riblets, especially towards the posterior region of the shell. Interior smooth, but with strongly crenulate margin. Notch almost obsolete.

Dimensions.—Holotype (Mitchell River). Length, 22 mm. Width, 19 mm. Height, 14.5 mm. One example from Clifton Bank, Muddy Creek (Dennant coll.) has a length of 22.5 mm. and a height of 17 mm.

Observations.—This species is very distinct. It could not be easily confused with *M. occlusa*, on account of the uniformly beaded ribs and heavy shell; moreover the apex is posteriorly situated in this species, whereas in *M. occlusa* it is central or nearly so.

Occurrence.—Balcombian (Oligocene), Muddy Creek (Dennant coll.). Janjukian (Miocene), Gellibrand River (Dennant coll.); Skinner's and Mitchell River, Bairnsdale (Dennant and Cudmore colls.); also Table Cape, Tasmania (W. L. May coll.).

MONTFORTULA SQUAMOIDEA, sp. nov. (Plate II., fig. 26.)

Description.—Shell large, depressed, roundly oval in outline. Apex not prominent, subcentral. Anterior slope of shell gently convex, posterior, concave. Ornament consisting of about 30 rounded and partially scaly ribs, between which are secondary and sometimes tertiary riblets of the same character. The growth lines crossing the interspaces give rise to a feeble cancellation. Inner surface polished, the margin being relieved with short sulci corresponding with the external ribs.

Dimensions.—Length, 24 mm. Width, 21 mm. Height, 7.25 mm.

Observations.—The only other species of this genus with which the above is likely to be confused is *M. gemmata*. In this, however, the shell is more depressed and the ribs sharper and fewer.

Occurrence.—Balcombian (Oligocene), Muddy Creek, Clifton Bank (Dennant and Annear coll.). Janjukian (Miocene), Western Beach, Corio Bay (Dennant).

Genus *Tugalia*, Gray.

TUGALIA CRASSIRETICULATA, Pritchard, sp.

Scutus (*Tugalia*) *crassireticulata*, Pritchard, 1896, Proc. Roy. Soc. Vict., vol. VIII., p. 125, pl. III., figs 4, 5.

Observations.—This species is apparently confined to the Table Cape beds, and is there very rare. The holotype is in the National Museum Collection, and the only other we have examined is a fragmentary specimen in Mr. Cudmore's collection. The relationships of this species are with the living *Tugalia parmophoidea*⁹ and *T. cicatricosa*, A. Adams.¹⁰ From the former it differs in the more oval outline and is altogether a much larger shell, being about two and a half times larger than the recent shell; but the apex in both *T. crassireticulata* and *T. parmophoidea* agrees very closely. On the other hand *T. crassireticulata* is easily separable from *T. cicatricosa* by the character of the apex, which in the fossil does not show a cicatrix. In size the fossil specimen resembles *T. cicatricosa*, but the sides of the shell are much more depressed than in that species.

Occurrence.—Janjukian (Miocene), Table Cape, Tasmania (*Cras-satellites* bed); Holotype from Atkinson coll. in the National Museum, also coll. of F. A. Cudmore.

Genus, *Megatebennus*, Pilsbry.

MEGATEBENNUS CONCATENATUS, Crosse and Fischer, sp.

Fissurella concatenata, Cross and Fischer, 1864, Journ. Conchyl., ser. 3, vol. IV., No. 4, p. 348. Tenison Woods, 1877, Proc. Roy. Soc., Tasmania, for 1876, p. 102.

Fissurellidea malleata, Tate, 1882, Trans. Roy. Soc., S. Australia, vol. V., p. 46. Idem, 1893, ibid., vol. XVII., pt. I, p. 223. Harris, 1897, Cat. Tert. Moll. Australasia, p. 287, pl. VIII., figs 5a-c.

Megatebennus concatenatus, Crosse and Fischer, sp., Pritchard and Gatliff, 1903, Proc. Roy. Soc., Vict., vol. XV., pt. II., p. 182.

Fissurellidea malleata, Tate, Dennant and Kitson, 1903, Rec. Geol. Surv., Vict., vol. I., pt. 2, pp. 117 and 145.

Original description by Tenison Woods of fossil specimens as "*Fissurella concatenata*" in 1877, op. supra cit., p. 102:—

9.—*Emarginula parmophoidea*. Quoy and Gaimard, 1834, Voy. Astrolabe, Zool. III., p. 325, pl. LXVIII., figs. 15, 16.

10.—*Tugalia-cicatricosa*, A. Adams, Proc. Zool. Soc. Lond., 1852 (1851), p. 89.

"*Fissurella concatenata*, Crosse. Shell thin, oval, laterally and posteriorly depressed, tumid anteriorly, irregularly, concentrically ridged with lines of growth, and covered all over with fine hexagonal depressions which grow broader from apex to margin; foramen oval, with a conspicuous tubercle on each side, and widely margined beneath, interior margin enamelled, and above which the shell is undulately striate or sub-corrugated on the foraminal margin. Long 14, Lat. 10, Alt. 2½ mil. Easily distinguished by its hexagonal markings, in which it differs from any described." Tenison Woods also remarks that "the fossil forms are generally thinner and fragile, and more like the variety found near Sydney."

Observations.—This is an extremely variable species and is one of those Tertiary forms of mollusca which has a great range in time. It is found throughout the Tertiaries, from Balcombian to Werrikoonian, and is a living species along the Victorian coast, at Port Phillip and Western Port. It also occurs at Port Lincoln, South Australia, and Lake Macquarie, New South Wales. Our reference of Tate's *M. malleatus* to the living species has been further confirmed by Mr. Chas. Hedley, F.L.S., of the Australian Museum, Sydney.

It is interesting to note the different varietal forms appearing at the various geological stages or horizons. The older forms have the malleate or contused ornament generally of a finer grade than the later, Kalimnan and recent, forms. In outline also, the species is extraordinarily variable; for example, from the same bed, at the Clifton Bank, Muddy Creek, one can select a series of specimens showing modifications between an almost regularly ovate form, to one in which the anterior is almost acuminate. But in all these variations there is no distinct boundary line to separate the forms or definitely group them in any way. The fossil forms from the finer marl beds, especially in the Janjukian, as at Native Hut Creek, and from the Murray Cliffs, South Australia, show generally a much more delicate surface sculpture, whilst the acme of the coarse sculpturing seems to be reached in the Kalimnan of Muddy Creek.

The largest examples are found in the Balcombian of Muddy Creek, one from the Dennant collection having a length of 32.5 mm. and a width of 22.25 mm.

Occurrence.—Balcombian (Oligocene), Grice's Creek (F. A. Cudmore); Balcombe Bay (Cudmore and Dennant); Muddy Creek, lower beds (Dennant coll.). Janjukian (Miocene), Torquay; Skinner's, near Bairnsdale (F. A. Cudmore); Mitchell River, Bairnsdale (F. Chapman coll.); Native Hut Creek (T. S. Hall, in Cudmore coll.); Murgheboluc and Rutledge's (T.S.H. and F.A.C. coll.); Fyansford (Dennant coll.); Shelford (Dennant coll.); Murray River Cliffs, S.A. (F. A. Cudmore coll.); Table Cape, Tas. (F. A. Cudmore coll.). Kalimnan (Lower Pliocene), Muddy Creek, upper beds (Dennant coll.). Werrikoonian (Upper Pliocene), Limestone Creek, Glenelg River, Vic. (Dennant coll.).

MEGATEBENNUS LAQUEATUS, Tate sp.

Fissurellidaca laqueata, Tate, 1885, Southern Science Record, vol. I., No. 1, N.S., Jan. 1885, p. 1.

Fissurellidea laqueata, Tate, Dennant and Kitson, 1903, Rec. Geol. Surv. Vic., vol. I., pt. 2, p. 117.

Observations.—The long ovate shape and striate-reticulate ornament of this species renders it easily separable from *M. concatenatus*. Another distinguishing feature is the smooth interior of *M. laqueatus*, whereas that of *M. concatenatus* is radially sulcated.

The largest specimen known to us, from Muddy Creek, has a length of 21.5 mm., a width of 13.5 mm., and a height of 6 mm.

Occurrence.—Balcombian (Oligocene), Balcombe Bay and Muddy Creek (Dennant). Janjukian (Miocene), Torquay (F. A. Cudmore); Gellibrand (Dennant and Cudmore).

MEGATEBENNUS OMICRON, Crosse and Fischer sp.

Fissurella omicron, Crosse and Fischer, 1864, Journ. de Conch., ser. 3, vol. IV., p. 348. Idem, 1865, ibid., p. 41, pl. III. figs. 4-6. Pilsbry, in Tryon, 1890, Man. Conch., vol. XII. p. 174. pl. XXII. figs. 45-47. Pritchard and Gatliff, 1902, Proc. Roy. Soc. Vict., vol. XV. (N.S.) pt. I. p. 182.

Observations.—This species, like *M. concatenatus*, is a living form around the southern coast of Australia. In Victoria it is found in Port Phillip and Western Port. It does not have so extensive a geological range as *M. concatenatus*, its history commencing with the Miocene.

M. omicron is quite distinct from the preceding two species, both in shape and ornament, having a vellicate or pinched-up form of shell, the sides being almost concave and the foraminata apex salient. The ornament consists of fine ridge-like striae, crossed by fine growth-lines, which give it a sub-reticulate appearance.

The Shelford specimen has a length of 15 mm., whilst that of the Kalimnan specimen is 17 mm.

Occurrence.—Janjukian (Miocene), Shelford (Dennant coll.), Murray Cliffs, 4 miles below Morgan, S.A. (F. A. Cudmore coll.), Kalimnan (Lower Pliocene), Muddy Creek, upper beds (Dennant coll.).

Genus *Lucapinella*, Pilsbry.

LUCAPINELLA NIGRITA, Sowerby sp.

Fissurella nigrita, Sowerby, 1834, Proc. Zool. Soc. Lond., p. 127. Idem, 1841, Conch. Illustr., p. 6, No. 51, fig. 47. Reeve, 1849, Conch. Icon., vol. VI., pl. VI., fig. 41.

Megatebennus nigrita, Sow. sp., Pilsbry, in Tryon, 1890, Man. Conch., vol. XII., p. 187, pl. XLIV., figs. 97, 98.

Lucapinella nigrita, Sow. sp., Hedley, 1895, Proc. Roy. Soc. Vict., vol. VII., N.S., pp. 197, 198, pl. XI., figs. 1, 2.

Pritchard and Gatliff, 1903, *ibid.*, vol. XV., pt. II., p. 183. Dennant and Kitson, 1903, *Rec. Geol. Surv. Vict.*, vol. I., pt. 2, p. 138.

Observations.—The fossil examples are indistinguishable from the living ones, though usually rather polished or waterworn. In Victoria the living specimens are found in Western Port, Flinders, Anderson's Inlet and Kilcunda.

Occurrence.—Janjukian (Miocene). Murray Cliffs, 4 miles below Morgan (F. A. Cudmore coll.). Kalimnan (Lower Pliocene). Muddy Creek, upper beds (Dennant coll.).

Summary.

1.—The foregoing revision includes 23 species, belonging to 8 genera, viz., *Cellana*, *Patelloidea*, *Cocculina*, *Emarginula*, *Montfortula*, *Tugalia*, *Megatebennus* and *Lucapinella*.

2. Of these, 14 species are new,—

<i>Cellana cudmorei</i>	<i>E. dennanti</i>
<i>C. hentyi</i>	<i>E. maudensis</i>
<i>Patelloidea hamiltonensis</i>	<i>Montfortula aperturata</i>
<i>P. multiradialis</i>	<i>M. cainozoica</i>
<i>Cocculina praecompressa</i>	<i>M. gemmata</i>
<i>C. gunyoungensis</i>	<i>M. ponderosa</i>
<i>Emarginula delicatissima</i>	<i>M. squamoidea</i>

3.—Those species with the most persistent range in time are—

Patelloidea perplexa. Miocene to Recent.

Emarginula wannonensis. Oligocene to Lower Pliocene. Said to be living in New Zealand seas.

Megatebennus concatenatus. Oligocene to Recent
" *omicron*. Miocene to Recent.

4.—The slight variations seen in the above specific forms, continuing throughout an enormous period and dating back in some cases to the older Tertiary, are not striking enough nor of such constant character to justify even varietal names.

5.—This continuity of character in the mollusca over long periods indicates a fairly uniform phase of sedimentation, and where variations have occurred, must have been of a local character, which obviated the rapid evolution of form requiring new adaptations to their surroundings.

6.—From the foregoing work, it is patent to the authors that the description of new forms of fossil mollusca must be studied and compared with the living faunas, especially of the same geographical area. Otherwise unnecessary duplication of nomenclature will ensue.

7.—The complete list of species herein mentioned, with their range in time, is as follows:—

Cellana cudmorei, sp. nov. Miocene.
 .. *hentyi*, sp. nov. Lower Pliocene.
Patelloida hamiltonensis, sp. nov. Lower Pliocene.
 .. *multiradialis*, sp. nov. Lower Pliocene.
 .. *perplexa*, Pilsbry, sp. Miocene and Recent.
Cocculina praecompressa, sp. nov. Oligocene and Miocene.
 .. *gunyoungensis*, sp. nov. Oligocene.
Emarginula delicatissima, sp. nov. Oligocene and Miocene.
 .. *dennanti*, sp. nov. Oligocene and Miocene.
 .. *maudensis*, sp. nov. Miocene.
 .. *transenna*, T. Woods. Oligocene and Miocene.
 .. *wannonensis*, Harris. Oligocene, Miocene and Lower Pliocene (?) Recent in New Zealand.
Montfortula aperturata, sp. nov. Oligocene and Miocene.
 .. *cainozoica*, sp. nov. Oligocene.
 .. *gemma*, sp. nov. Oligocene and Miocene.
 .. *occlusa*, Tate sp. Oligocene and Miocene.
 .. *ponderosa*, sp. nov. Oligocene and Miocene.
 .. *squamoidea*, sp. nov. Oligocene and miocene.
Tugalia crassireticulata, Pritchard. Miocene.
Megatebennus concatenatus, Crosse and Fischer sp. Oligocene, Miocene, Pliocene and Recent.
 .. *laqueatus*, Tate sp. Oligocene and Miocene.
 .. *omicron*, Crosse and Fischer sp. Miocene, Pliocene and Recent.
Lucapinella nigrita, Sowerby sp. Miocene, Lower Pliocene and Recent.

EXPLANATION OF PLATES.

N.B.—All Types are in the National Museum collection.

Fig. 1.—*Cellana cudmorei*, sp. nov. Internal view of shell, in polyzoal limestone. Janjukian. Batesford. Holotype; coll. F. A. Cudmore. $\times \frac{9}{8}$.

.. 2.—*Cellana hentyi*, sp. nov. Apical aspect. Kalimnan. Forsyth's Grange Burn near Hamilton. Nat. Mus. coll. Type; pres., by F. Chapman. $\times \frac{7}{4}$.

.. 3.—*Patelloida hamiltonensis*, sp. nov. Apical aspect. Kalimnan. Muddy Creek, upper beds. Holotype. Dennant coll. $\times \frac{23}{13}$.

.. 4.—*Patelloida multiradialis*, sp. nov. Apical aspect. Balcombian. Upper part of Clifton Bank, Lower Muddy Creek beds. Holotype, coll. F. Chapman; pres. Nat. Mus. coll. $\times \frac{5}{3}$.

.. 5.—*Cocculina praecompressa*, sp. nov. Apical aspect. Balcombian. Lower beds, Muddy Creek. Holotype; pres. by J. H. Young. $\times 2$.

.. 6.—Ditto, Lateral aspect. \times circ. 2.

.. 7.—*Cocculina praecompressa*, sp. nov. Apical aspect. Janjukian. Shelford. Paratype. Dennant coll. \times circ. 2.

.. 8.—Ditto, Lateral aspect, \times circ. 2.



